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The Enhancement Of Mathematical Reasoning Ability Of Senior High School Students' Through Generative Learning

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Abstract

Mathematical reasoning ability is important ability needed by everyone in their life. In fact, the ability has not been developed well, even in senior high school students. Generative learning is expected to trigger the development of the ability. This study aims to examine the students' enhancement of mathematical reasoning ability through the application of generative learning. The study is a quasi experiment with Pretest and Postest Control Group Design. The subject of this research is students of grade X of two Public Senior High Schools (high and medium level), and one Private Senior High School (lower level) in Pekanbaru. The research instrument consists of one set of mathematical reasoning ability test. Data are analyzed by using Kolmogorov-Smirnov test (z-test), Levene test, t-test, Brown-Forsythe test, and two-way Anova.The results of study indicate that the students' enhancement of mathematical reasoning ability through generative learning was higher than conventional learning, whether it is viewed from a whole, based on school level, or mathematical prior knowledge; and based on Hake criteria, the students' enhancement of mathematical reasoning ability is classified middle. In addition, the result of study also indicate that: there is interaction effect between learning approaches and school levels toward the students' enhancement of mathematical reasoning ability, and there is no significant interaction effect between learning approaches and mathematical prior knowledge toward the students' enhancement of mathematical reasoning ability.

Keywords: mathematical reasoning ability, and generative learning

INTRODUCTION

Mathematical reasoning ability (MRA) is one of the competencies that must be achieved by students in learning mathematics from elementary through senior high school (Depdiknas, 2006). This is because through mathematical reasoning, students are able to: draw logical conclusions; providean explanationof themodels, pictures, facts, attributes, relationships, or patterns exist; estimate the answers and the solutions, using pattern of relationships to analyze the situation, or make an analogy, generalization, and formulate a conjecture, ask the opposite example, follow the rules of inference, checking the validity of the argument, prove, and draw up a valid argument, and arrange direct evidence, indirect proof and proof by induction (Sumarmo, 2005).

Mathematical reasoning is an important part in mathematics, because of through mathematical reasoning students can solve mathematical problems. In addition, the topics of mathematics and mathematical reasoning are inter-relatedand can not beseparated, because the topics of mathematics are understood through reasoning; and mathematical reasoning is understood and practiced through learning mathematics (Depdiknas, 2002).

It is necessary to seek for learning approaches that can provide opportunities and encourage students to practice their MRA. The reality on the ground shows that learning activity is still dominated by teachers, students do not play an active role in learning,

and students are not given the opportunity to use the power of their reason to solve a problem with a variety of strategies; thus, students just accept anything that is delivered by teachers without understanding what they mean. Learning like this is called conventional learning or CVL (Helmaheri, 2004).

The learning who make of passive students are not possible to improve their MRA. Therefore, teachers should striveto make the students active in learning, be able to solve problems with a variety of strategies, and be able to draw logical conclusions based on the facts and the relevant sources (Shurter and Pierce in Sumarmo, 1987). One of the learning that can enhance students'active involvement and can improve student MRA is generative learning (GL). It is based on the premise that the measures contained in GL can make the students learn to be active in constructing knowledge and improving student's MRA. To improve MRA, students are given an opportunity to practice a variety of strategies to solve the problem, such as: modeling, graphics, pictures or arguments logically consistent with the concept that they understand (Osborn & Wittrock in Hulukati, 2005).

Furthermore, the measures of GL can provide opportunities for students to respond and solve problems independently and creatively. Teachers act more as facilitators and mediators to encourage students to do their own problem-solving activity and the activity of communicating mathematical concepts obtained through solving a mathematical problem.

One of the topics in mathematics in senior high schools related to everyday life is a system ofline are quations and inequalities in one variable (SPLPtSV), given in grate X (odd semester). For the grade X senior high school, the topic is an advance because the junior high school of grade VIII, the students have been taught the system of linear equations in two and three variables, so hopefully they are easier to understand the topics in grade X Senior High School. In reality, students' learning out comes is low. One reason is that it is difficult for students to make a mathematical model of a given story problems (problems that are non-routine contextual) and finish edit, and students are notable to resolve the situation of the problem by following logical arguments and drawing logical conclusions from solving the problems obtained; which is an indicator of MRA.

Noting the importance of students MRA in learning mathematics, the students MRA should be enhanced. Therefore a research has been conducted to improve MRA through GL in students of grade X Senior High School in Pekanbaru with the topics SPLPtSV, which was focused on the school levels (upper, middle, and lower), and mathematical prior knowledge or MPK (high, middle, and lower). The research question: (1) Are the enhancement of mathematical reasoning ability of students who receiving GL are higher than students who receiving CVL; as reviewed as a whole, based on school level, and MPK category?; (2) is there interaction effect between learning approaches and school levels toward the students' enhancement of mathematical reasoning ability?, and (3) is there significant interaction effect between learning approaches and mathematical prior knowledge toward the students' enhancement of mathematical reasoning ability?

The purpose of this study is to determine the enhancement in students MRA through GL and CVL in terms of: (a) the whole students, (b) the level of school, and students MPK, particularly on the topics SPLPtSV. The expected benefit is concerning

with one of the alternative learnings, especially in topics SPLPtSV that can enhance students' MRA.

RESEARCH METHOD

This study is a quasi-experimental research control group design with pretest and postest (Pretest and Postest Control Group Design),which is described as follows:

O X O
O O (Ruseffendi, 2005)

In the implementation of this research, are used three levels of schools, namely upper, middle, and lower. From each selected school, two classes were selected: one group was for experiments and another group was for control. The experimental group was given special treatment (X) GL, while the control group was not given special treatment. Determination of the sample on the experimental and control groups considered grouping students in school. Each group study was given pretest and postest (O) to measure students' of MRA.

The study population was all senior high school studentsin Pekanbaru in the academic year 2010/2011. Determination of sample classes based on stratified sampling. The sample of the study was senior high school students of grade X school level (upper, middle, and lower) in the city of Pekanbaru. At the upper level, the school selected as a research site were SMAN 5 Pekanbaru, with grade X.10 as an experiment group and grade X.8 as a control group. Middle school level which is selected is SMAN 7 Pekanbaru, with grade X.7 as an experimental group and X.6 grade as a control group. At the lower level, senior high school Nurul Falah Pekanbaru was selected in which the student of grade X.1 as used a group experiment and students of grade X.3 used as a control group.

To obtain the data in this study, a test instrument was used for measuring students' of MRA before and after the study was carried out, both for the experimental group and a control group and the test was in the form of descriptions. The test conceived and developed are based on instrument procedures which are good and true. After the test were improved by the input of the validator, trials were conducted. MRA test tested on 40 students of grade XI SMAN 5 Pekanbaru. Furthermore, the reliability and the validity of the instrument used the Cronbach-Alpha, at level $\alpha = 0.05$ and N=40 obtained $r_{tabel}=0.31$. The results of calculation of the reliability and validity of 6 items MRA test, gained 4 items MRA which was declared as valid tests with reliability test of 0.81 which meant high. The analysis showed that the MRA test can be used for the research.

The data obtained were analyzed to determine the magnitude of the enhencement of students' of MRA gain normalized using the formula (N-Gain), namely:

$$g = \frac{posttest\ score - pretest\ score}{maximum\ ideal\ score - pretest\ score}$$ Hake (in Meltzer, 2002)

The results of the calculation of the gain were interpreted using the classification of Hake (1999), as shown in Table 1.

Table 1. Classification of Gain (g)

The magnitude of g	Interpretation
$g > 0,7$	High
$0,3 < g \leq 0,7$	Middle
$g \leq 0,3$	Lower

In addition, data were analyzed using the Kolmogorov-Smirnov test (z-test), Levene test, t-test, Brown-Forsythe test and two-way Anova.

RESULTS AND DISCUSSION

Research Results

The results of descriptive analysis of the data students' of MRA each school level in groups of learning, are presented in Figure 1.1.

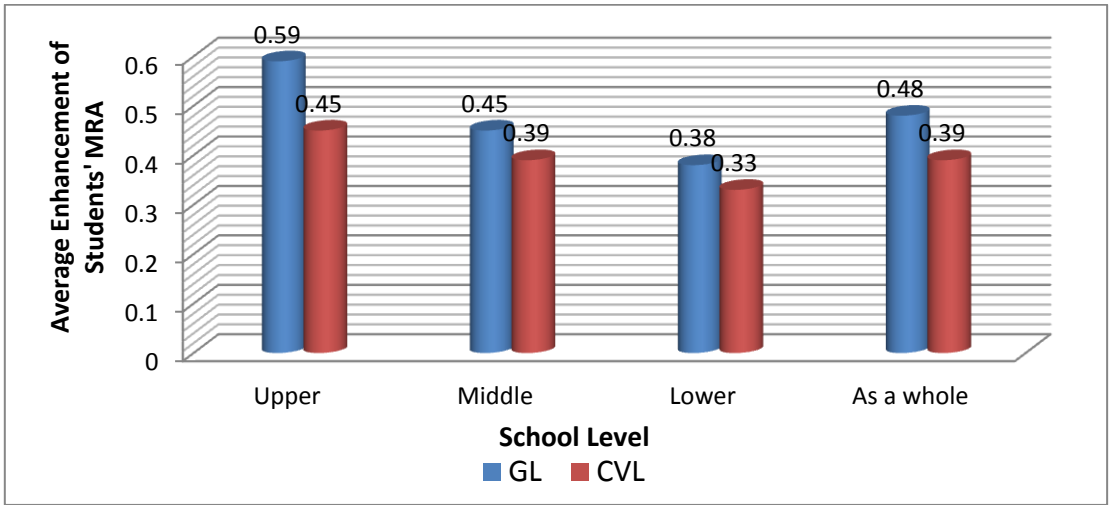

Figure 1.1:Average Enhancement of Students' MRAfor each School Level in both groups of Learning

Figure 1.1 shows that average enhancement of students' MRA (N-Gain) for each school level in GL group is higher than CVL group. This can be seen from average enhancement of students' MRA for upper school level that received GL of 0.59 is higher than average enhancement of students' MRA for upper school level that received CVL of 0.45. The average enhancement of students' MRA for middle school level that received GL of 0.45 is higher than average enhancement of students' MRA for middle school level that received CVL of 0.39. Similary, the average enhancement of students' MRA for lower school level that received GL of 0.38 is higher than average enhancement of students' MRA for lower school level that received CVL of 0.33. Overall, the average enhancement of students' MRA that received GL of 0.48 is higher than average enhancement of students' MRA that received CVL of 0.39.Based on Hake criteria, the students' enhancement of MRA in three school levels that received GL is

classified middle; similary, students who received CVL for upper and middle school levels, but for lower school level, the students' enhancement of MRA is classified lower.

Further, tests of enhancement was conducted of students' MRA for each school level in group of learning. Before doing the test, the normality of data was tested (KS-Z) with results of the samples were normally distributed. Results of significance testof enhancement of students' MRA in both groups of learning using t-test obtained that there was average enhancement of students' MRAfor each school levels (upper, middle, and lower) after obtaining GL and CVL.

The results of the test of homogeneity of variance data using Levene's test are obtained that the data variance enhancement of students' MRA for each school level in groups of learning are not homogeneous.The results of the t'-test (equal variences not assumed) of difference enhancement of students' MRA for each school level in groups of learning are obtained that students' in all three school levels (upper, middle, and lower) who obtain GL has an average enhancement of MRA is significantly higher than students who received CVL.

The results of descriptive analysis of the data students' of MRA for each MPK category in groups of learning, are presented in Figure 1.2.

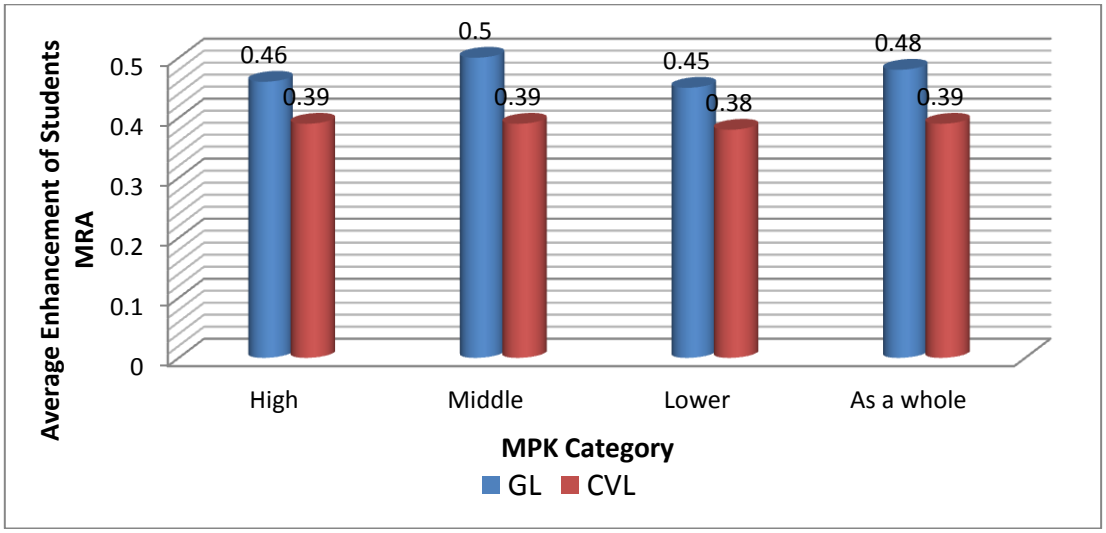

Figure 1.2: Average Enhancement of Students' MRA each MPK Category in groups of Learning

In Figure 1.2 it can be seen that average enhancement of students' MRA (N-Gain) for each MPK category in GL groupis higher than CVL group. This can be seen from average enhancement of students' MRA for high MPK that received GL of 0.46 (more than 0.39) is higher than average enhancement of students' MRA for high MPK that received CVL. The average enhancement of students' MRA for middle MPK that received GL of 0.50 (more than 0.39) is higher than average enhancement of students' MRA for middle MPK that received CVL. Similary, the average enhancement of students' MRA for lower MPK that received GL of 0.45 (more than 0.38) is higher than average enhancement of students' MRA for lower MPK that received CVL. Overall, the average enhancement of students' MRA that received GL of 0.48 is higher than average

enhancement of students' MRA that received CVL of 0.39. Based on Hake criteria, the average enhancement of students' MRA in three MPK category (high, middle and lower) both that received GL or CVL is classified middle.

Further, tests of enhancement was conducted of students' MRA for each MPK category in group of learning. Before doing the test, the normality of data was tested (KS-Z) with results of the samples were normally distributed. Results of significance test of enhancement of students' MRA for each MPK category in groups of learning using t-test obtained that students' in all three MPK groups (high, middle and lower), both that received GL or CVL have average enhancement of students' MRA is classified middle.

The results of the test of homogeneity of variance data using Levene's test are obtained that the data variance enhancement of students' MRA for each MPK category in groups of learning are not homogeneous.The results of difference test the students' enhancement of MRA each MPK category based on group of learning by using Brown-Forsythe test is obtained that for each MPK category; students who obtained GL have average enhancement of MRA significantly is higher than students who obtained CVL. When it is seen from average enhancement of students' MRA each MPK categoryand learning group have average difference, each high MPK category and lower of 0.07; while middle MPK category of 0.11. So, for each MPK category havethe students enhancement of MRA, both GL group or CVL group; but the students enhancement of MRA GL group is higher than CVL group.

Interaction between Learning and School Level toward the Students' Enhancement of MRA

The results of test the presence or absence of interaction effect between learning and school level toward the students' enhancement of MRA are presented in Table 1.

Table 1. Interaction of Test between Learning and School Level toward the Students' Enhancement of MRA

Source	Number of Squares	df	Average Squares	F	*Sig.* (*2-tailed*)	H_o
Learning	0,335	1	0,335	30,867	0,000	Rejected
School Level	0,911	2	0,455	41,950	0,000	Rejected
Interaction	0,066	2	0,033	3,055	0,050	Rejected
Errors	1,889	174	0,011			
Total	37,202	180				

Table 1 shows that there is interaction between learning and school level toward the students' enhancement of MRA. This can be seen from the sig. value interaction is less than or equal to 0.05 so that H_o is rejected. So there is interaction effect between learning and school level toward the students' enhancement of MRA. It means that there is a simultaneous effect between learning and school level toward the students'enhancement of MRA. This interaction effect can be seen graphically in Figure 1.3.

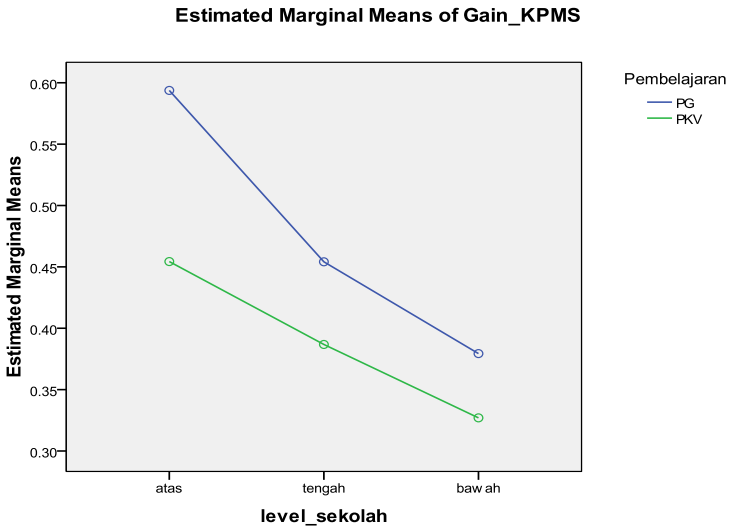

Figure 1.3: Interaction between learning and school level toward the students' enhancement of MRA.

Figure 1.3 shows that average difference the students' enhancement of MRA between upper school level, middle and lower in GL and CVL groups, turns out difference is the greatest in upper school level (upper 0.14; middle 0.07 and lower 0.05). This means that GL is more suitable to be applied in upper school level than at middle school level and lower, because of difference the students' enhancement of MRA between GL and CVL are the most. In other words, these findings indicate that students in upper school level received of greater benefit through GL inthe students' enhancement of MRA.

The results of test the presence or absence of interaction effect between learning and MPK toward the students' enhancement of MRA are presented in Table 2.

Tabel 2. Interaction of Test between Learning and MPK toward the Students' Enhancement of MRA

Source	Number of Squares	df	Average Squares	F	*Sig.* (*2-tailed*)	H_o
Learning	0,274	1	0,274	16,784	0,000	Rejekted
MPK	0,028	2	0,014	0,860	0,425	Accepted
Interaction	0,013	2	0,006	0,385	0,681	Accepted
Errors	2,838	174	0,016			
Total	37,202	180				

Table 2 shows that there is no interaction between learning and MPK toward the students' enhancement of MRA. This can be seen from the sig. value interaction is greater than 0.05 so that H_o is accepted. So there is no interaction effect between learning and MPK toward difference the students' enhancement of MRA. It means that MPK does not effect toward difference the students'enhancement of MRA, but

difference the students'enhancement of MRA are caused by learning differences are used, it is seen from sig. value of 0.00. Figure 1.4 below clarify the absence of such interactions.

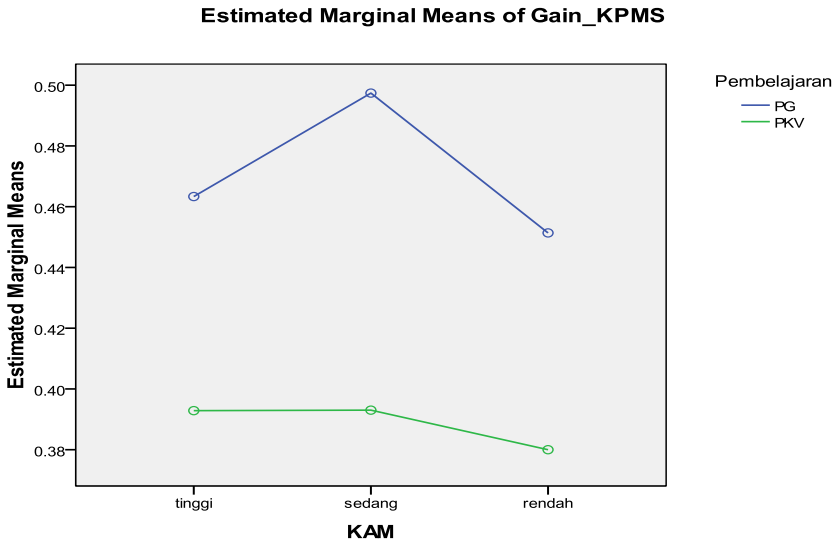

Figure 1.4: Interaction between learning and MPK toward the students' enhancement of MRA.

Figure 1.4 shows that average difference the students' enhancement of MRA between high MPK, middle and lower in GL and CVL groups, turns out difference is the greatest in middle MPK (high 0.07; middle 0.10 and lower 0.07). Mathematically, average difference the students' enhancement of MRA between the three MPK groups is different, but statistically, average difference the students' enhancement of MRA between the three MPK groups is not different (relatively similar). From Figure 1.4 can be seen it's like there is interaction between learning and MPK toward the students' enhancement of MRA, but in fact it is no interaction, it can be seen from probability value or sig. of 0.68. In the GL group, middle MPK tend to look is higher than high MPK and low. Interaction between learning and MPK toward the students' enhancement of MRA significantly are nothing.

RESULT AND DISCUSSION

Based on statistical tests it can be concluded that learning had a significant influence in the students' enhancement of MRA. Similarly school level have a significant influence in the students' enhancement of MRA. This finding is supported by average enhancement of students' MRA for each school level that received GL, is always higher than average enhancement of students' MRA for each school level that received CVL.

The average enhancement of students' MRA for upper school level that received GL of 0.59 (greather than 0.45) is higher than average enhancement of students' MRA for upper school level that received CVL. At the middle school level, average

enhancement of students' MRA that received GL of 0.45 (greather than 0.39) is higher than average enhancement of students' MRA for middle school level that received CVL. Similary, the averageenhancement of students' MRA for lower that received GL of 0.38 (greather than 0.33) is higher than average enhancement of students' MRA for lower school level that received CVL.

The average enhancement of students' MRA that received GL in upper school level is higher than average enhancement of students'MRA in middle school level and is higher than lower school level. Similarly, the average enhancement of students' MRA in middle school level is higher than average enhancement of students' MRA in lower school level. Influential school level factors toward differences enhancement of students' MRA, likely due to students from the upper school level, identical to the students who have high MPK, tend to have higher reasoning than the middle level school and lower. The join of students in a group with some students who have high ability, middle and lower, making the discussion process run smoothly. Sharing ideas in group, of course trains students in solving problems related to MRA.

Students with high MPK who obtained GL have average enhancement of MRA of 0.46 (greather than 0.39) is higher than students with high MPK who obtained CVL; students with middle MPK who obtained GL have average enhancement of MRA of 0.50 (greather than 0.39) is higher than students with middle MPK who obtained CVL. Similarly, students with lower MPK who obtained GL have average enhancement of MRA of 0.45 (greather than 0.38) is higher than students with lower MPK who obtained CVL. Thus, MPK provide a significant impact toward the students' enhancement of MRA, both who obtained GL or who obtained CVL; but the students' enhancement of MRA who obtained GL is higher than students who obtained CVL.

The average enhancement of students' MRA tha treceived GL who have middle MPK was higher than students who have high MPK and lower. This is possible because many capable students were joined in group and they can share their ideas, thus making the discussion processrun smoothly. Students who have high MPK is higher than students who have lower MPK. This is understandable because to solve various problems in mathematical reasoning, it is needed the readiness of knowledge to solve the problem.

The enhancement in average of MRA shows that students at all three school level who received GL has enhancement of MRA higher than students who received CVL. The enhancement in average of students' MRA in upper school level is also higher than the enhancement in average of student's MRA in middle and lower school level after receives GL. Thus there is a significant difference in the three school level is to enhance of students' MRA. These results indicate that the higher the level of the school, the higher the cognitive abilities of students in that school level.

The results of study as shown in two-way Anova test in Table 1 shows that there is interaction effect between learning and school level toward the students' enhancement of MRA. This means that there is a simultaneous effect between learning and school level toward the students' enhancement of MRA, in other words interaction effect between learning and school level resulted of differences in significant improvement toward the students'enhancement of MRA.

Interactions between learning and MPK toward the students' enhancement of MRA is not significant, it means there is no interaction effect between learning and MPK toward the students' enhancement of MRA. This can be seen in Table 2 and Figure 1.4, interaction between learning and MPK of significance figure of more than 0.05 is 0.68. In the absence of this interaction showed that factors joint between learning and MPK there are no significant effect in development of students MRA. Absence of effect of this interaction shows that differences in learning and MPK does not make a difference the students' enhancement of MRA after learning. MPK does not affect

toward differeces the students' enhancement of MRA. The differences of students' enhancement of MRA is just caused by differences in learning were used.

CONCLUSION AND RECOMMENDATIONS

Based on the result of research and discussion that has been mentioned previously, we can conclude: students who received GL have average of enhancement of MRA are higher than students who received CVL, be reviewed of the whole, each school level (upper, middle and lower) and each MPK category (high, middle and lower). Base on Hake criteria, the students' enhancement of MRA as whole, school level and MPK category; both that received GL or CVL are classified middle.

There is interaction between learning and school level toward the students' enhancement of MRA. It means there is a simultaneous effect between learning and school level toward the students' enhancement of MRA. In other words, interaction between learning and school level resulted of differences in significant of enhancement toward enhancement of MRA. There is no interaction between learning and MPK towards the students' enhancement of MRA. It means MPK does not effect toward difference enhancement of MRA, but the difference is caused by differences in learning were used.

It is recommended to mathematics teachers that GL can be used as an alternative learning to enhance of students' MRA, especially on the topic SPLPtSV and generally on the topic that containing story problem about contextual everyday life with respect to school level and MPK group.

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